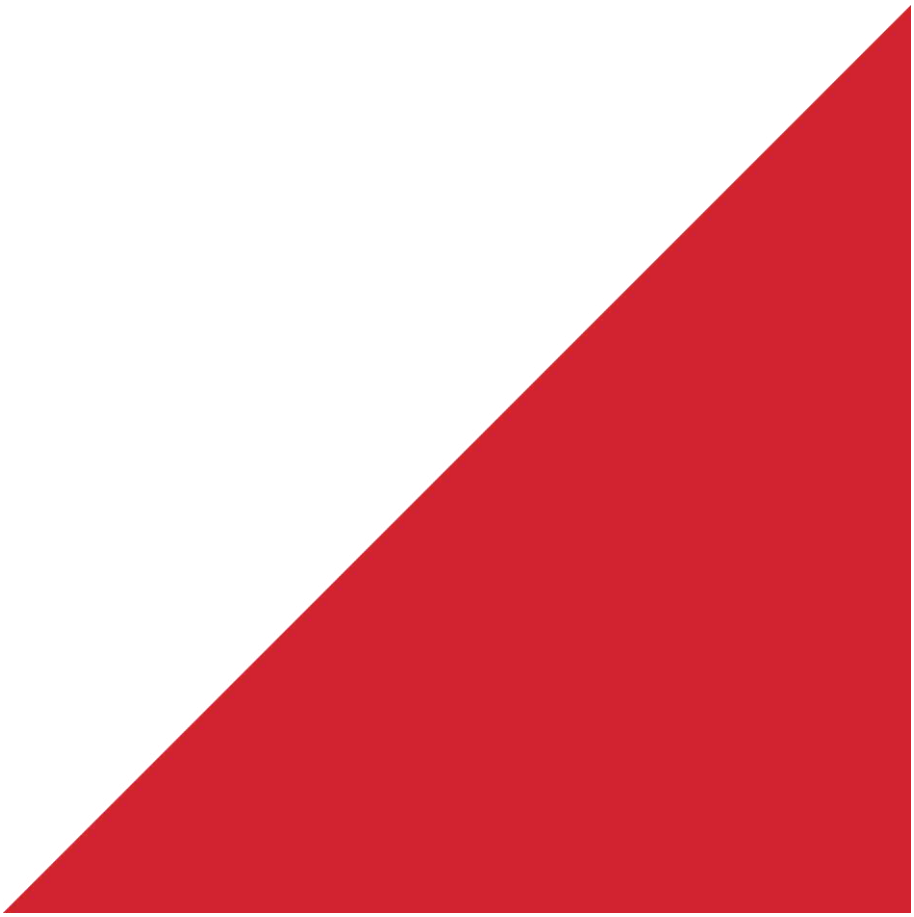
*Christchurch City Council*

# Briggs Row Housing Complex PRO 3519

## Detailed Engineering Evaluation

## Quantitative Assessment Report



*Christchurch City Council*

# Briggs Row Housing Complex

# Quantitative Assessment Report

## 31 Winchester Street, Lyttelton,

### Revision History

| Revision No. | Prepared By | Description | Date |
|---|---|---|---|
| 1 | AS | Final V1 | 28/03/2014 |
| 2 | LMH | Draft V2 – Following Strengthening | 16/11/2015 |
| 3 | SPT | Final V3 – Following Strengthening | 21/12/2015 |

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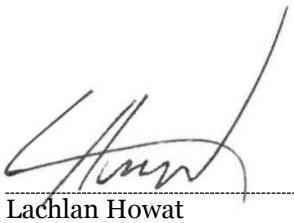

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*Christchurch City Council*

# Briggs Row Housing Complex

# Quantitative Assessment Report

## 31 Winchester Street, Lyttelton,

# Summary

Briggs Row Housing Complex
PRO 3519

Detailed Engineering Evaluation
Quantitative Report - Summary
Final V3

## Background

This is a summary of the quantitative report for the Briggs Row Housing Complex, and is based on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011. This assessment covers the 4 residential units on the site.

## Key Damage Observed

The residential units suffered minor damage to non-structural elements. This included cracking of the interior wall and ceiling linings. Structural damage to the residential units was generally minor. This damage was deemed low enough to not affect the capacities of the buildings.

## Level Survey

All floor slopes assessed in a laser level survey. All were less than the 5mm/m limitation set out in the MBIE guidelines [6].

## Internal Lining Nail Spacings

The internal lining nail spacings were measured on site to vary between 200-300mm.

## Critical Structural Weaknesses

No critical structural weaknesses were found in any of the buildings.

## Indicative Building Strength

Table A: Summary of Seismic Performance by Blocks

| Block | %NBS (Prior to Strengthening) | %NBS (Following Strengthening) | Indicative Floor Levels | Nail Spacings |
|---|---|---|---|---|
| PRO 3519 B001 (Block A) | 35% | 100% | Pass | Pass |

The residential units have capacities of 100% NBS (as a result of the structural strengthening scheme outlined below) and are limited by the in-plane shear capacity of the lined timber-framed shear walls.

## Original Recommendations

It is recommended that;

1. Structural schemes be developed such that the seismic capacity of the subfloor is increased to more than 67% of NBS.
2. Cosmetic repairs be undertaken as required.
3. Remove construction material from subfloor space.

## Remediation and Structural Strengthening

On the 16th of December 2014 building consent exemption BCN/2014/12204 for "Strengthening work to Briggs row housing units - Addition of sub-floor bracing" was accepted by Christchurch City Council and issued by Opus to the Christchurch City Council Social Housing Unit to repair the damage sustained in the Canterbury Earthquake sequence. This plan addressed the recommendations in the following way:-

1. A strengthening works scheme was developed with works completed in July 2015 increasing the seismic capacity of the subfloor bracing to 100% NBS.
2. Cosmetic repairs were completed as part of the strengthening works.
3. Construction material was removed from around the new bracing during the repairs.

The strengthening included adding new anchor piles and plywood linings to increase the seismic capacity of the subfloor. This work has been completed as of July 2015 and increases the capacity of the structure to 100%NBS.

The repair and strengthening works met all recommendations in the Detailed Engineering Evaluation report of March 2014.

# Contents

# 1 Introduction

Opus International Consultants Limited has been engaged by Christchurch City Council to undertake a detailed seismic assessment of the Briggs Row Housing Complex, located at 31 Winchester Street, Lyttelton, following the Canterbury earthquake sequence since September 2010. The site was visited by Opus International Consultants on 12 November 2013 and the subfloors were re-inspected on 24 March 2014.

The purpose of the assessment is to determine if the buildings in the village are classed as being earthquake prone in accordance with the Building Act 2004.

The seismic assessment and reporting have been undertaken based on the qualitative and quantitative procedures detailed in the Detailed Engineering Evaluation Procedure (DEEP) document (draft) issued by the Structural Engineering Society (SESOC) [2] [3] [4] [5].

# 2 Compliance

This section contains a brief summary of the requirements of the various statutes and authorities that control activities in relation to buildings in Christchurch at present.

## 2.1 Canterbury Earthquake Recovery Authority (CERA)

CERA was established on 28 March 2011 to take control of the recovery of Christchurch using powers established by the Canterbury Earthquake Recovery Act enacted on 18 April 2011. This act gives the Chief Executive Officer of CERA wide powers in relation to building safety, demolition and repair. Two relevant sections are:

**Section 38 – Works**

This section outlines a process in which the chief executive can give notice that a building is to be demolished and if the owner does not carry out the demolition, the chief executive can commission the demolition and recover the costs from the owner or by placing a charge on the owners' land.

**Section 51 – Requiring Structural Survey**

This section enables the chief executive to require a building owner, insurer or mortgagee to carry out a full structural survey before the building is re-occupied.

We understand that CERA require a detailed engineering evaluation to be carried out for all buildings (other than those exempt from the Earthquake Prone Building definition in the Building Act). CERA have adopted the Detailed Engineering Evaluation Procedure (DEEP) document (draft) issued by the Structural Engineering Society (SESOC) on 19 July 2011. This document sets out a methodology for both initial qualitative and detailed quantitative assessments.

It is anticipated that a number of factors, including the following, will determine the extent of evaluation and strengthening level required:

1. The importance level and occupancy of the building.

2. The placard status and amount of damage.

3. The age and structural type of the building.

4. Consideration of any critical structural weaknesses.

Christchurch City Council requires any building with a capacity of less than 34% of New Building Standard (including consideration of critical structural weaknesses) to be strengthened to a target of 67% as required under the CCC Earthquake Prone Building Policy.

## 2.2 Building Act

Several sections of the Building Act are relevant when considering structural requirements:

**Section 112 - Alterations**

This section requires that an existing building complies with the relevant sections of the Building Code to at least the extent that it did prior to the alteration. This effectively means that a building cannot be weakened as a result of an alteration (including partial demolition).

The Earthquake Prone Building policy for the territorial authority shall apply as outlined in Section 2.3 of this report.

**Section 115 – Change of Use**

This section requires that the territorial authority is satisfied that the building with a new use complies with the relevant sections of the Building Code 'as near as is reasonably practicable'.

This is typically interpreted by territorial authorities as being 67% of the strength of an equivalent new building or as near as practicable. This is also the minimum level recommended by the New Zealand Society for Earthquake Engineering (NZSEE).

**Section 121 – Dangerous Buildings**

This section was extended by the Canterbury Earthquake (Building Act) Order 2010, and defines a building as dangerous if:

1. In the ordinary course of events (excluding the occurrence of an earthquake), the building is likely to cause injury or death or damage to other property; or
2. In the event of fire, injury or death to any persons in the building or on other property is likely because of fire hazard or the occupancy of the building; or
3. There is a risk that the building could collapse or otherwise cause injury or death as a result of earthquake shaking that is less than a 'moderate earthquake' (refer to Section 122 below); or
4. There is a risk that other property could collapse or otherwise cause injury or death; or
5. A territorial authority has not been able to undertake an inspection to determine whether the building is dangerous.

### Section 122 – Earthquake Prone Buildings

This section defines a building as earthquake prone (EPB) if its ultimate capacity would be exceeded in a 'moderate earthquake' and it would be likely to collapse causing injury or death, or damage to other property.

A moderate earthquake is defined by the building regulations as one that would generate loads 33% of those used to design an equivalent new building.

### Section 124 – Powers of Territorial Authorities

This section gives the territorial authority the power to require strengthening work within specified timeframes or to close and prevent occupancy to any building defined as dangerous or earthquake prone.

### Section 131 – Earthquake Prone Building Policy

This section requires the territorial authority to adopt a specific policy for earthquake prone, dangerous and insanitary buildings.

## 2.3 Christchurch City Council Policy

Christchurch City Council adopted their Earthquake Prone, Dangerous and Insanitary Building Policy in October 2011 following the Darfield Earthquake on 4 September 2010.

The policy includes the following:

1. A process for identifying, categorising and prioritising Earthquake Prone Buildings, commencing on 1 July 2012;
2. A strengthening target level of 67% of a new building for buildings that are Earthquake Prone;
3. A timeframe of 15-30 years for Earthquake Prone Buildings to be strengthened; and,
4. Repair works for buildings damaged by earthquakes will be required to comply with the above.

The council has stated their willingness to consider retrofit proposals on a case by case basis, considering the economic impact of such a retrofit.

If strengthening works are undertaken, a building consent will be required. A requirement of the consent will require upgrade of the building to comply 'as near as is reasonably practicable' with:

- The accessibility requirements of the Building Code.
- The fire requirements of the Building Code. This is likely to require a fire report to be submitted with the building consent application.

Where an application for a change of use of a building is made to Council, the building will be required to be strengthened to 67% of New Building Standard or as near as is reasonably practicable.

## 2.4 Building Code

The Building Code outlines performance standards for buildings and the Building Act requires that all new buildings comply with this code. Compliance Documents published by The Department of Building and Housing can be used to demonstrate compliance with the Building Code.

On 19 May 2011, Compliance Document B1: Structure, was amended to include increased seismic design requirements for Canterbury as follows:

- Increase in the basic seismic design load for the Canterbury earthquake region (Z factor increased to 0.3 equating to an increase of 36 – 47% depending on location within the region);
- Increased serviceability requirements.

## 2.5 Institution of Professional Engineers New Zealand (IPENZ) Code of Ethics

One of the core ethical values of professional engineers in New Zealand is the protection of life and safeguarding of people. The IPENZ Code of Ethics requires that:

*Members shall recognise the need to protect life and to safeguard people, and in their engineering activities shall act to address this need.*

*1.1 Giving Priority to the safety and well-being of the community and having regard to this principle in assessing obligations to clients, employers and colleagues.*

*1.2 Ensuring that responsible steps are taken to minimise the risk of loss of life, injury or suffering which may result from your engineering activities, either directly or indirectly.*

All recommendations on building occupancy and access must be made with these fundamental obligations in mind.

# 3 Earthquake Resistance Standards

For this assessment, the building's earthquake resistance is compared with the current New Zealand Building Code requirements for a new building constructed on the site. This is expressed as a percentage of new building standard (%NBS). The loadings are in accordance with the current earthquake loading standard NZS1170.5 [1].

A generally accepted classification of earthquake risk for existing buildings in terms of %NBS that has been proposed by the NZSEE 2006 [2] is presented in Figure 1 below.

| Description | Grade | Risk | %NBS | Existing Building Structural Performance | Improvement of Structural Performance | |
|---|---|---|---|---|---|---|
| | | | | | Legal Requirement | NZSEE Recommendation |
| Low Risk Building | A or B | Low | Above 67 | Acceptable (improvement may be desirable) | The Building Act sets no required level of structural improvement (unless change in use) This is for each TA to decide. Improvement is not limited to 34%NBS. | 100%NBS desirable. Improvement should achieve at least 67%NBS |
| Moderate Risk Building | B or C | Moderate | 34 to 66 | Acceptable legally. Improvement recommended | | Not recommended. Acceptable only in exceptional circumstances |
| High Risk Building | D or E | High | 33 or lower | Unacceptable (Improvement required under Act) | Unacceptable | Unacceptable |

**Figure 1: NZSEE Risk Classifications Extracted from table 2.2 of the NZSEE 2006 AISPBE Guidelines [2]**

Table 1 below compares the percentage NBS to the relative risk of the building failing in a seismic event with a 10% risk of exceedance in 50 years (i.e. 0.2% in the next year).

**Table 1: %NBS compared to relative risk of failure**

| Percentage of New Building Standard (%NBS) | Relative Risk (Approximate) |
|---|---|
| >100 | <1 time |
| 80-100 | 1-2 times |
| 67-80 | 2-5 times |
| 33-67 | 5-10 times |
| 20-33 | 10-25 times |
| <20 | >25 times |

## 3.1 Minimum and Recommended Standards

Based on governing policy and recent observations, Opus makes the following general recommendations:

### 3.1.1 Occupancy

The Canterbury Earthquake Order[1] in Council 16 September 2010, modified the meaning of "dangerous building" to include buildings that were identified as being EPB's. As a result of this, we would expect such a building would be issued with a Section 124 notice, by the Territorial Authority, or CERA acting on their behalf, once they are made aware of our assessment. Based on information received from CERA to date and from the MBIE guidance document dated December 2012 [6], this notice is likely to prohibit occupancy of the building (or parts thereof), until its seismic capacity is improved to the point that it is no longer considered an EPB.

### 3.1.2 Cordoning

Where there is an overhead falling hazard, or potential collapse hazard of the building, the areas of concern should be cordoned off in accordance with current CERA/territorial authority guidelines.

### 3.1.3 Strengthening

Industry guidelines (NZSEE 2006 [2]) strongly recommend that every effort be made to achieve improvement to at least 67%NBS. A strengthening solution to anything less than 67%NBS would not provide an adequate reduction to the level of risk.

It should be noted that full compliance with the current building code requires building strength of 100%NBS.

### 3.1.4 Our Ethical Obligation

In accordance with the IPENZ code of ethics, we have a duty of care to the public. This obligation requires us to identify and inform CERA of potentially dangerous buildings; this would include earthquake prone buildings.

[1] This Order only applies to buildings within the Christchurch City, Selwyn District and Waimakariri District Councils authority.

# 4 Background Information

## 4.1 Building Descriptions

The site contains 4 residential units which were constructed in 1968. A site plan showing the location of the units, numbered 1 to 4, is shown in Figure 2. Figure 3 shows the location of the site in Christchurch City and Figure 4 shows the location within the Lyttelton area. The units are grouped together to form a block of four units.


Figure 2: Site plan of Briggs Row Housing Complex.

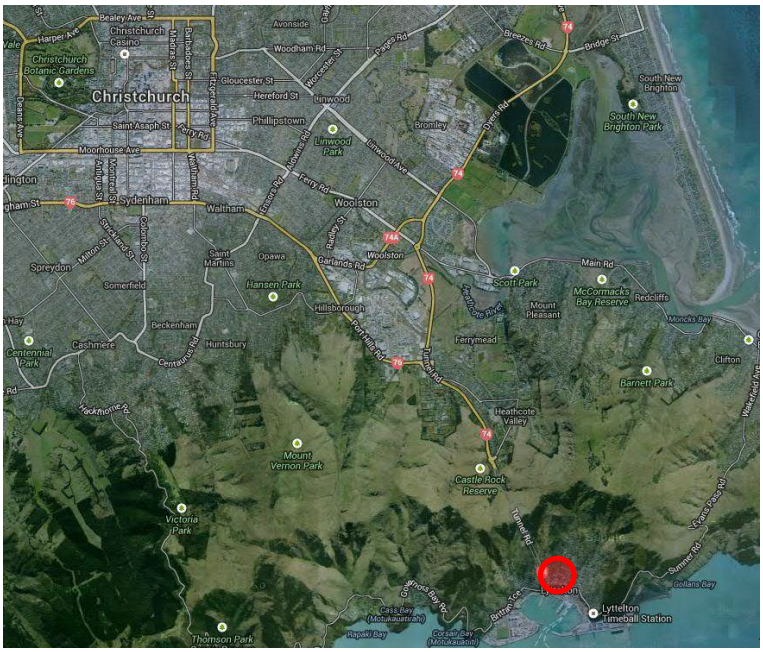



Figure 3: Location of Briggs Row (circled) relative to Christchurch City CBD (Source: Google Earth).


**Figure 4 - Location of Briggs Row in Lyttelton.**

The residential units are timber-framed buildings with diagonal timber braces. The roof structure comprises of timber roof framing supporting lightweight metal roofing. The walls and ceilings are lined with plasterboard. External walls are clad with lightweight timber weatherboards. Foundations consist of ordinary concrete piles with timber jack studs. There is a concrete perimeter wall on the east and south sides. There is a large subfloor on the west side which is covered by plywood panels. The original chimneys have been removed although the shape of these is still evident on the outsides of Units 1 and 4. The roofs of Units 2, 3, and 4 are mono slope while the roof of Unit 1 is pitched.

The units are separated by 190mm thick concrete block work fire walls which are reinforced to the perimeter.

There is minimal longitudinal subfloor bracing in the units. The plywood which currently forms the barrier to the subfloor is not properly framed and does not adequately transfer loads to the foundations. There is currently no strip footing for the loads to transfer to.

During the subfloor inspection it was noted that several members were rotted and cracking. There were large piles of soil, bricks and other construction debris under the units and in some cases these meant the concrete (structural) piles could not be inspected. These piles of material have buried some timber members which will now be more prone to rotting.

Figure 5 shows a typical floor plan of a residential unit produced from site measurements by Opus. Figure 6 shows a typical cross section, taken from original documentation. The roof is that of Unit 1.

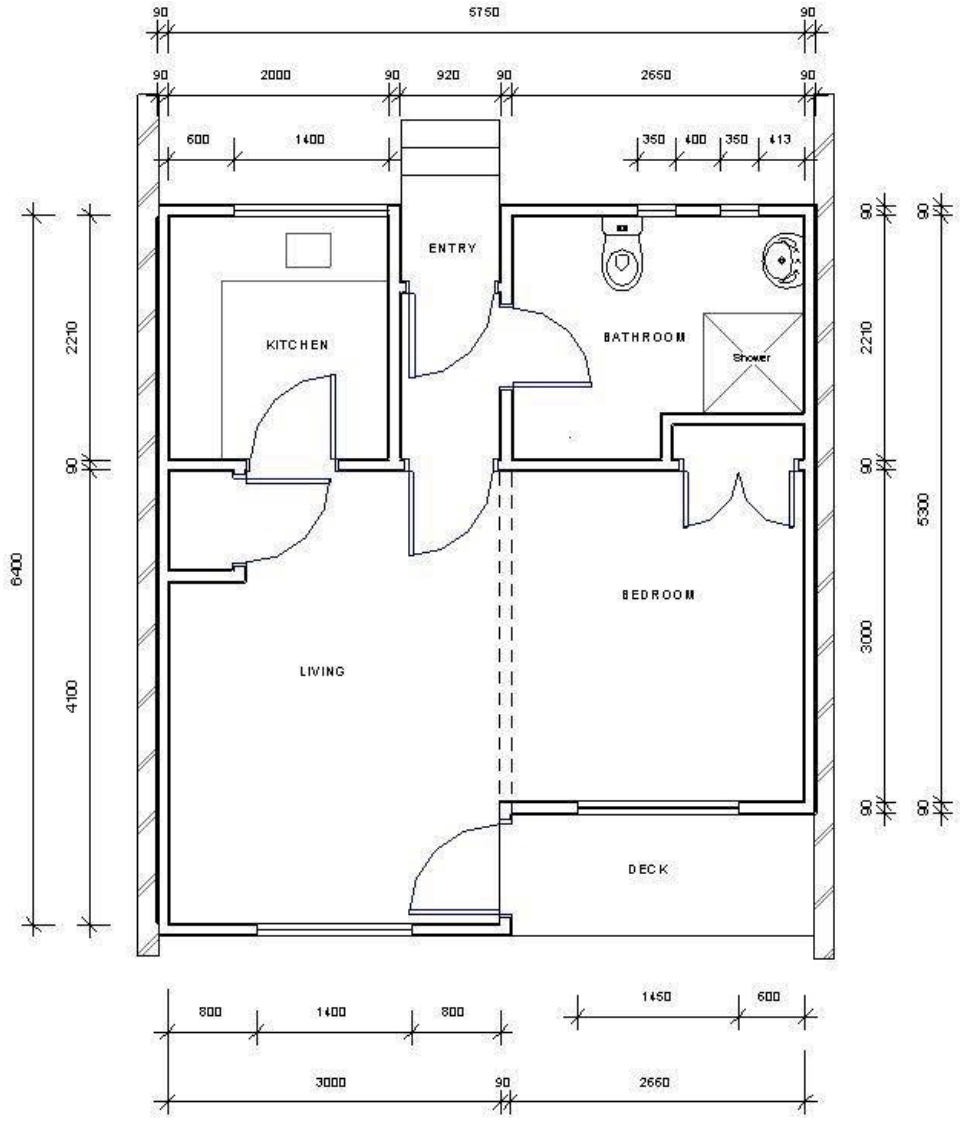



**Figure 5: Typical partial floor plan of residential unit blocks.**

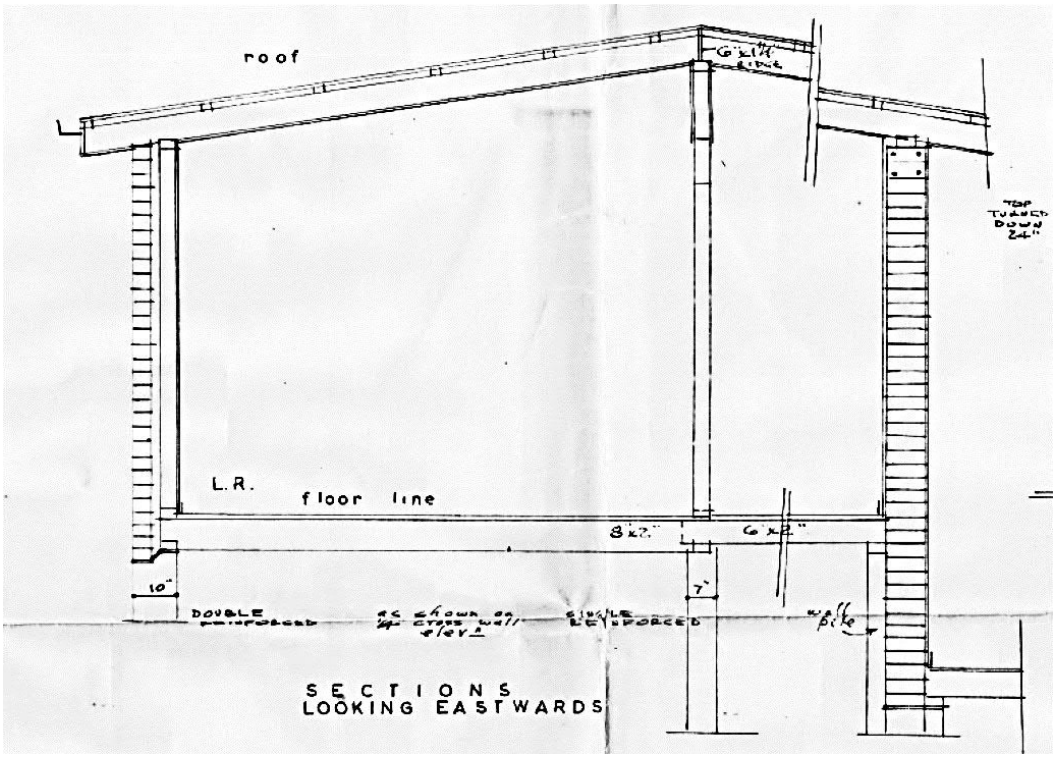



Figure 6: Typical cross-section of Briggs Row.

## 4.2 Survey

### 4.2.1 Post 22 February 2011 Rapid Assessment

A structural (Level 2) assessment of the buildings/property was undertaken on 3 March 2011 by Opus International Consultants.

### 4.2.2 Level Survey

A full level survey was not deemed to be necessary at Briggs Row as it is located in a Port Hills zone. Properties in Port Hill zones suffered nil damage due to liquefaction and/or settlement but are potentially at risk of rock fall, cliff collapse and land slips. In lieu of a full level survey, a laser level was placed in each unit so that differentials in vertical levels could be measured at the extreme ends of the unit. These values could then be used to determine the floor slope of the entire unit. For this site, all floor slopes were less than the 5mm/m limitation imposed by MBIE guidelines.

Table 2: Summary of the Level Survey

| Block | Unit No. | Comment | Maximum Fall* |
|---|---|---|---|
| A | 1 | Pass | - |
| | 2 | Pass | - |
| | 3 | Pass | - |
| | 4 | Pass | - |

* Values are only recorded if greater than 5mm/m

### 4.2.3 Nail Spacings

The internal lining nail spacings were measured on site to vary between 200-300mm.

## 4.3 Original Documentation

The following documentation was provided by the Christchurch City Council:

- 750/14 – Lyttelton Borough Council – Pensioners Cottages – p. 1/1 – Elevations, plans, cross-sections, details, perspective view – 1969
- Proposed alterations – Briggs Row Units – Peter Dunbar Architectural Designer – 23/6/2009 Resource Consent RMA 92014024/1

In addition, a typical floor plan has been produced by Opus to help confirm as-built measurements.

Copies of the design calculations were not provided.

# 5 Original Damage

This section outlines the damage to the buildings that was observed during site visits. It is not intended to be a complete summary of the damage sustained by the buildings due to the earthquakes. Some forms of damage may not be able to be identified with a visual inspection only.

It is noticeable that none of the residential units have suffered any significant damage.

Note: Any photo referenced in this section can be found in Appendix A.

## 5.1 Residual Displacements

The results of the level survey indicate that no significant ground settlement has occurred in the units due to the earthquakes.

## 5.2 Foundations

Foundation damage was limited to a small area of spalling in the concrete foundation perimeter footing on the corner of Unit 4 (photo 9).

## 5.3 Primary Gravity Structure

No damage was evident in the timber framing or roof structure.

## 5.4 Primary Lateral-Resistance Structure

Some stepped cracking was observed on the face of the block work fire wall of Unit 3. No damage was observed in any other units.

## 5.5 Non Structural Elements

Minimal cracking of plasterboard ceiling diaphragms and wall linings was observed in the units (photo 10). This form of damage is common throughout the units. Cracked external weatherboards were also observed on some faces (photo 11).

## 5.6 General Observations

The buildings appeared to have performed reasonably well, as would be expected for buildings of this type, during the earthquakes. They have suffered distributed amounts of minor damage which is typical of the construction type and age of construction.

# 6 Detailed Seismic Assessment

The detailed seismic assessment has been based on the NZSEE 2006 [2] guidelines for the "Assessment and Improvement of the Structural Performance of Buildings in Earthquakes" together with the "Guidance on Detailed Engineering Evaluation of Earthquake Affected Non-residential Buildings in Canterbury, Part 2 Evaluation Procedure" [3] draft document prepared by the Engineering Advisory Group on 19 July 2011, and the SESOC guidelines "Practice Note – Design of Conventional Structural Systems Following Canterbury Earthquakes" [5] issued on 21 December 2011.

As the residential units have the same floor plan, the analysis was simplified by conducting the analysis of one multi-unit block with similar cladding and using this for all multi-unit blocks.

## 6.1 Critical Structural Weaknesses

The term Critical Structural Weakness (CSW) refers to a component of a building that could contribute to increased levels of damage or cause premature collapse of a building.

No CSWs were identified in the buildings.

## 6.2 Quantitative Assessment Methodology

The assessment assumptions and methodology have been included in Appendix B. A brief summary follows:

Hand calculations were performed to determine seismic forces from the current building codes. These forces were applied globally to the structure and the capacities of the walls were calculated and used to estimate the %NBS. The walls, highlighted in Figure 7 and Figure 8, were used for bracing in their respective directions.

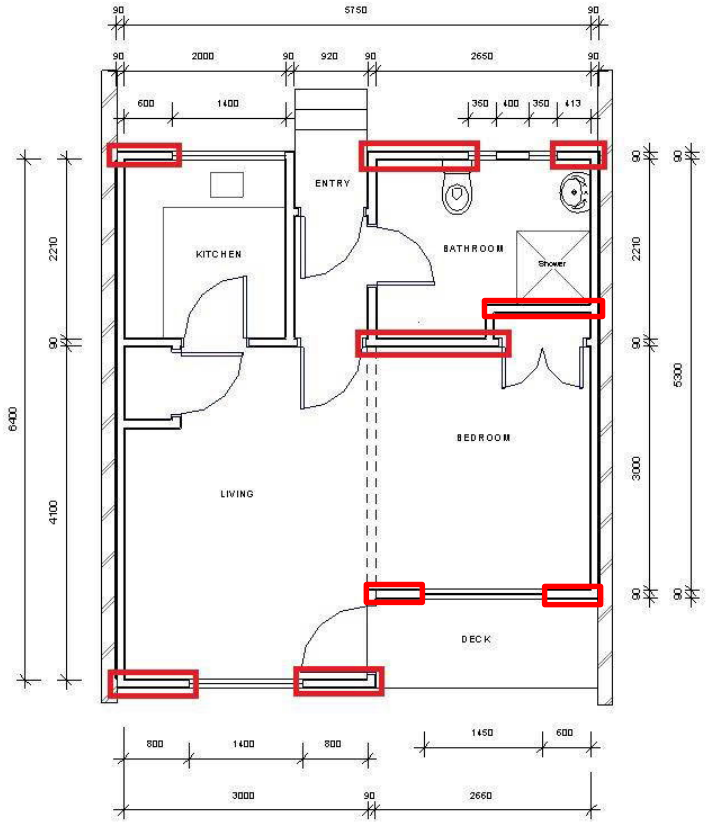



Figure 7: Walls used for bracing in the longitudinal direction.

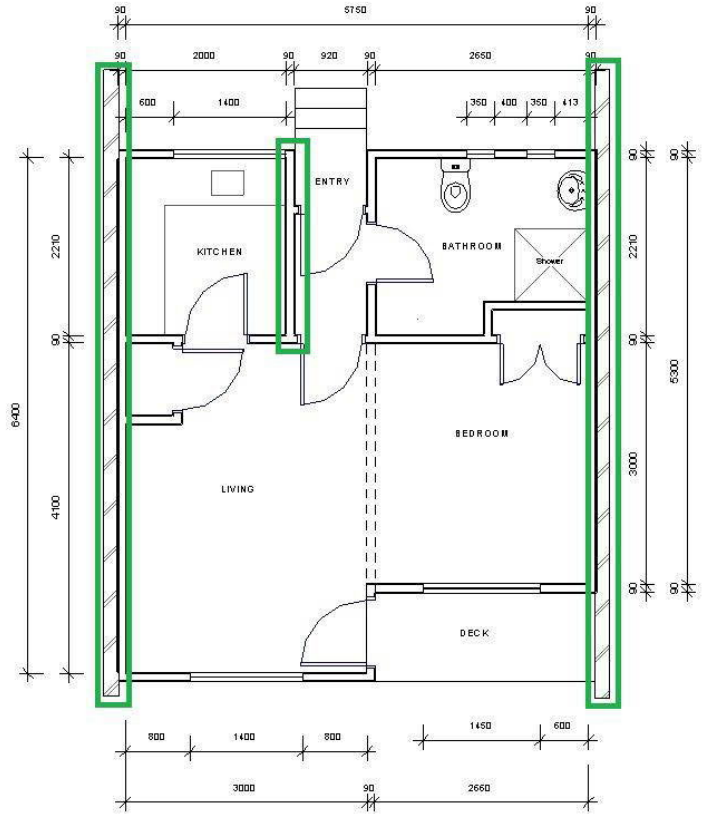



Figure 8: Walls used for bracing in the transverse direction.

## 6.3 Limitations and Assumptions in Results

The observed level of damage suffered by the buildings was deemed low enough to not affect their capacity. Therefore the analysis and assessment of the buildings was based on them being in an undamaged state. There may have been damage to the buildings that was unable to be observed that could cause the capacity of the buildings to be reduced; therefore the current capacity of the buildings may be lower than that stated.

The results have been reported as a %NBS and the stated value is that obtained from our analysis and assessment. Despite the use of best national and international practice in this analysis and assessment, this value contains uncertainty due to the many assumptions and simplifications which are made during the assessment. These include:

- Simplifications made in the analysis, including boundary conditions such as foundation fixity.
- Assessments of material strengths based on limited drawings, specifications and site inspections.
- The normal variation in material properties which change from batch to batch.
- Approximations made in the assessment of the capacity of each element, especially when considering the post-yield behaviour.
- Construction is consistent with normal practise of the era in which constructed.

## 6.4 Assessment

A summary of the structural performance of the buildings is shown in Table 3 (which has now been superseded by Table 4). Note that the values given represent the worst performing elements in the building, where these effectively define the building's capacity. Other elements within the building may have significantly greater capacity when compared with the governing elements.

Table 3: Summary of Seismic Performance prior to Structural Strengthening (Superseded)

| Building Description | Critical element | % NBS based on calculated capacity in longitudinal direction | % NBS based on calculated capacity in transverse direction. |
|---|---|---|---|
| Block A | In plane bracing walls | 100% | 100% |
| | Sub Floor Bracing | 35% | 100% |

Table 4: Summary of Seismic Performance following Structural Strengthening

| Building Description | Critical element | % NBS based on calculated capacity in longitudinal direction | % NBS based on calculated capacity in transverse direction. |
|---|---|---|---|
| Block A | In plane bracing walls | 100% | 100% |
| | Sub Floor Bracing | 100% | 100% |

# 7 Geotechnical Summary

CERA indicates that Briggs Row is located in a Port Hills zone (as shown in Figure 9). This classification suggests there is a low geological hazard risk due to rock fall, cliff collapse and land movement.


**Figure 9: CERA Technical Categories map (loc. starred).**

There is no evidence to suggest that further geotechnical investigation is warranted for this site.

# 8 Conclusions

- The residential units have a capacity of 100% NBS, as limited by the in-plane shear capacity of the lined shear walls. They are deemed to be a 'low risk' in a design seismic event according to NZSEE guidelines.

# 9 Original Recommendations (March 2014)

It is recommended that;

1. Structural schemes be developed such that the seismic capacity of the subfloor is increased to more than 67% of NBS.
2. Cosmetic repairs be undertaken as required.
3. Remove construction material from subfloor space.

# 10 Remediation and Structural Strengthening

On the 16th of December 2014 building consent exemption BCN/2014/12204 for "Strengthening work to Briggs row housing units - Addition of sub-floor bracing" was accepted by Christchurch City Council and issued by Opus to the Christchurch City Council Social Housing Unit to repair the damage sustained in the Canterbury Earthquake sequence. This plan addressed the recommendations in the following way:-

1. A strengthening works scheme was developed with works completed in July 2015 increasing the seismic capacity of the subfloor bracing to 100% NBS.
2. Cosmetic repairs were completed as part of the strengthening works.
3. Construction material was removed from around the new bracing during the repairs.

The strengthening included adding new anchor piles and plywood linings to increase the seismic capacity of the subfloor. This work has been completed as of July 2015 and increases the capacity of the structure to 100%NBS.

The repair and strengthening works met all recommendations in the Detailed Engineering Evaluation report of March 2014.

# 11 Limitations

- This report is based on an inspection of the buildings and focuses on the structural damage resulting from the Canterbury Earthquake sequence since September 2010. Some non-structural damage may be described but this is not intended to be a complete list of damage to non-structural items.
- Our professional services are performed using a degree of care and skill normally exercised, under similar circumstances, by reputable consultants practicing in this field at this time.
- This report is prepared for the Christchurch City Council to assist in the assessment of any remedial works required for the Briggs Row Housing Complex. It is not intended for any other party or purpose.

# 12 References

[1] NZS 1170.5: 2004, Structural design actions, Part 5 Earthquake actions, Standards New Zealand.

[2] NZSEE (2006), Assessment and improvement of the structural performance of buildings in earthquakes, New Zealand Society for Earthquake Engineering.

[3] Engineering Advisory Group, Guidance on Detailed Engineering Evaluation of Earthquake Affected Non-residential Buildings in Canterbury, Part 2 Evaluation Procedure, Draft Prepared by the Engineering Advisory Group, Revision 5, 19 July 2011.

[4] Engineering Advisory Group, *Guidance on Detailed Engineering Evaluation of Non-residential buildings, Part 3 Technical Guidance*, Draft Prepared by the Engineering Advisory Group, 13 December 2011.

[5] SESOC (2011), Practice Note – Design of Conventional Structural Systems Following Canterbury Earthquakes, Structural Engineering Society of New Zealand, 21 December 2011.

[6] MBIE (2012), Repairing and rebuilding houses affected by the Canterbury earthquakes, Ministry of Building, Innovation and Employment, December 2012.

# Appendix A – Original Report Photographs

| Briggs Row Housing Complex | | |
|---|---|---|
| No. | Item description | Photo |
| Residential Units Layout | | |
| 1. | Site view |  |
| 2. | Typical exterior elevation (end) |  |

| | | |
|---|---|---|
| 3. | Typical exterior elevation (front) |  |
| 4. | Typical unit exterior elevation (front) |  |
| 5. | Typical exterior elevation (back) |  |

| | | |
|---|---|---|
| 6. | Typical floor void |  |
| 7. | Typical internal lining nail spacings (300mm) |  |

| | | |
|---|---|---|
| 8. | Typical unit living area |  |
| 9. | Spalling of concrete on perimeter footing |  |
| 10. | Typical cracking of wall lining |  |

| | | |
|---|---|---|
| 11. | Cracked weatherboard |  |
| 12. | Typical sub floor jack stud |  |

| | | |
|---|---|---|
| 13. | Tall, concrete piles 800mm proud of ground level. |  |
| 14. | Typical subfloor framing. |  |

# Appendix B –Strengthening Scheme Photographs

| Briggs Row Housing Complex Strengthening | | |
|---|---|---|
| No. | Item description | Photo |
| Strengthening | | |
| 1. | External View of Completed Bracing. |  |
| 2. | External View of Completed Bracing. |  |

| | | |
|---|---|---|
| 3. | Internal View of Completed Bracing to unit 3. |  |
| 4. | External View of Completed Bracing to Unit 3/4. |  |
| 5. | Adequate Nail spacing provided to new bracing elements. |  |

| | | |
|---|---|---|
| 6. | Connections of New Framing to existing foundation walls. |  |
| 7. | Connections of New Framing to existing foundation walls and flooring. |  |

| | | |
|---|---|---|
| 8. | Anchor Pile Connection |  |

# Appendix C - Methodology and Assumptions

## Seismic Parameters

As per NZS 1170.5:

- T < 0.4s (assumed)
- Soil: Category D
- Z = 0.3
- R = 1.0 (IL2, 50 year)
- N(T,D) = 1.0

For the analyses, a μ of 2 was assumed for the residential units.

## Analysis Procedure

As the units are small and have a number of closely spaced walls in both directions, the fibrous plaster board ceilings are assumed to be capable of transferring loads to all walls. It was therefore assumed that a global method could be used to carry the forces down to ground level in each direction. Bracing capacities were found by assuming a certain kN/m rating for the walls along each line. Due to the relatively unknown nature of the walls, the kN/m rating was taken as 3 kN/m for all timber walls with an aspect ratio (height: length) of less than 2:1. This was scaled down to zero kN/m at an aspect ratio of 3.5:1 as per NZSEE guidelines. %NBS values were then found through the ratio of bracing demand to bracing capacity for all walls in each direction.

## Additional Assumptions

Further assumptions about the seismic performance of the buildings were:

- Connections between all elements of the lateral load resisting systems are detailed to adequately transfer their loads sufficiently and are strong enough so as to not fail before the lateral load resisting elements.

# Appendix D – Updated CERA DEE Spreadsheet

**Detailed Engineering Evaluation Summary Data** V1.14

**Location**

| | | | | | | |
|---|---|---|---|---|---|---|
| Building Name: | Briggs Row Housing Complex | | | | Reviewer: | Mary Ann Halliday |
| | Unit | No: | Street | | CPEng No: | 67073 |
| Building Address: | | 31 | Winchester Street, Lyttelton | | Company: | Opus International Consultants |
| Legal Description: | | | | | Company project number: | 6-QC319.00 |
| | | | | | Company phone number: | 03-363-5400 |
| | Degrees | Min | Sec | | | |
| GPS south: | 43 | 36 | 4.90 | | Date of submission: | 16-Nov-15 |
| GPS east: | 172 | 43 | 12.15 | | Inspection Date: | 12/11/2013 |
| | | | | | Revision: | 1 |
| Building Unique Identifier (CCC): | PRO3519 | | | | Is there a full report with this summary? | yes |

**Site**

| | | | |
|---|---|---|---|
| Site slope: | slope >1 in 5 | Max retaining height (m): | |
| Soil type: | | Soil Profile (if available): | |
| Site Class (to NZS1170.5): | D | | |
| Proximity to waterway (m, if <100m): | | If Ground improvement on site, describe: | |
| Proximity to clifftop (m, if < 100m): | | | |
| Proximity to cliff base (m,if <100m): | | Approx site elevation (m): | |

**Building**

| | | | | |
|---|---|---|---|---|
| No. of storeys above ground: | 1 | single storey = 1 | Ground floor elevation (Absolute) (m): | |
| Ground floor split? | yes | | Ground floor elevation above ground (m): | |
| Storeys below ground | 0 | | | |
| Foundation type: | timber piles | | if Foundation type is other, describe: | |
| Building height (m): | 3.00 | | height from ground to level of uppermost seismic mass (for IEP only) (m): | |
| Floor footprint area (approx): | 152 | | | |
| Age of Building (years): | 45 | | Date of design: | 1965-1976 |
| Strengthening present? | no | | If so, when (year)? | |
| | | | And what load level (%g)? | |
| Use (ground floor): | multi-unit residential | | Brief strengthening description: | |
| Use (upper floors): | | | | |
| Use notes (if required): | | | | |
| Importance level (to NZS1170.5): | IL2 | | | |

Gravity Structure

| | | | |
|---|---|---|---|
| Gravity System: | frame system | | |
| Roof: | timber framed | rafter type, purlin type and cladding | |
| Floors: | timber | joist depth and spacing (mm) | |
| Beams: | none | overall depth x width (mm x mm) | |
| Columns: | timber | typical dimensions (mm x mm) | |
| Walls: | non-load bearing | 0 | |

Lateral load resisting structure

| | | | | |
|---|---|---|---|---|
| Lateral system along: | lightweight timber framed walls | **Note: Define along and across in detailed report!** | note typical wall length (m) | |
| Ductility assumed, μ: | 2.00 | | | |
| Period along: | 0.10 | 0.00 | estimate or calculation? | estimated |
| Total deflection (ULS) (mm): | | | estimate or calculation? | |
| maximum interstorey deflection (ULS) (mm): | | | estimate or calculation? | |
| Lateral system across: | lightweight timber framed walls | | note typical wall length (m) | |
| Ductility assumed, μ: | 2.00 | | | |
| Period across: | 0.10 | 0.00 | estimate or calculation? | estimated |
| Total deflection (ULS) (mm): | | | estimate or calculation? | |
| maximum interstorey deflection (ULS) (mm): | | | estimate or calculation? | |

Separations:

| | | |
|---|---|---|
| north (mm): | | leave blank if not relevant |
| east (mm): | | |
| south (mm): | | |
| west (mm): | | |

Non-structural elements

| | | | |
|---|---|---|---|
| Stairs: | | | |
| Wall cladding: | other light | describe | weatherboard |
| Roof Cladding: | Metal | describe | corrugated iron |
| Glazing: | timber frames | | |
| Ceilings: | strapped or direct fixed | | |
| Services(list): | | | |

**Available documentation**

| | | | |
|---|---|---|---|
| Architectural | full | original designer name/date | Paul Pascoe and Linton Architects/1969 |
| Structural | partial | original designer name/date | |
| Mechanical | none | original designer name/date | |
| Electrical | none | original designer name/date | |
| Geotech report | none | original designer name/date | |

**Damage**

Site: (refer DEE Table 4-2)

| | | | |
|---|---|---|---|
| Site performance: | Good | Describe damage: | |
| Settlement: | none observed | notes (if applicable): | |
| Differential settlement: | none observed | notes (if applicable): | |
| Liquefaction: | none apparent | notes (if applicable): | |
| Lateral Spread: | none apparent | notes (if applicable): | |
| Differential lateral spread: | none apparent | notes (if applicable): | |
| Ground cracks: | none apparent | notes (if applicable): | |
| Damage to area: | none apparent | notes (if applicable): | |

Building:

| | | | |
|---|---|---|---|
| Current Placard Status: | green | | |
| Along Damage ratio: | 0% | Describe how damage ratio arrived at: | |
| Describe (summary): | | | |
| Across Damage ratio: | 0% | $Damage\_Ratio = \frac{(\%NBS(before) - \%NBS(after))}{\%NBS(before)}$ | |
| Describe (summary): | | | |
| Diaphragms Damage?: | no | Describe: | |
| CSWs: Damage?: | no | Describe: | |
| Pounding: Damage?: | no | Describe: | |
| Non-structural: Damage?: | no | Describe: | |

**Recommendations**

| | | | | |
|---|---|---|---|---|
| Level of repair/strengthening required: | none | | Describe: | |
| Building Consent required: | no | | Describe: | |
| Interim occupancy recommendations: | full occupancy | | Describe: | |
| Along Assessed %NBS before e'quakes: | 100% | ##### %NBS from IEP below | If IEP not used, please detail assessment methodology: | Equivalent Static |
| Assessed %NBS after e'quakes: | 100% | | | |
| Across Assessed %NBS before e'quakes: | 100% | ##### %NBS from IEP below | | |
| Assessed %NBS after e'quakes: | 100% | | | |

# Appendix E – Strengthening Scheme

Building Code Clause(s)B1 & B2.....

# PRODUCER STATEMENT – PS1 – DESIGN

(Guidance notes on the use of this form are printed on page 2)

**ISSUED BY:**Opus International Consultants.....
(Design Firm)

**TO:** Christchurch City Council .....
(Owner/Developer)

**TO BE SUPPLIED TO:** Christchurch City Council .....
(Building Consent Authority)

**IN RESPECT OF:**Superstructure Bracing.....
(Description of Building Work)

**AT:** Briggs Courts Housing Complex, 31 Winchester Street, Lyttleton.....
(Address)
..... **LOT**...Lot 1... **DP** ...27071 **SO** .....

We have been engaged by the owner/developer referred to above to provide To provide a permanent strengthening scheme to 100%NBS. services in respect of the requirements of
(Extent of Engagement)
Clause(s) B1 and B2.....of the Building Code for
All ☐ or Part only ☒ (as specified in the attachment to this statement), of the proposed building work.

The design carried out by us has been prepared in accordance with:

☒ Compliance Documents issued by the Ministry of Business, Innovation & EmploymentB1 & B2, NZS3604.... or
(verification method / acceptable solution)

☐ Alternative solution as per the attached schedule.....

The proposed building work covered by this producer statement is described on the drawings titled Briggs Row Subfloor strengthening plan. .....

and numbered N/A.....;
together with the specification, and other documents set out in the schedule attached to this statement.
**On behalf of the Design Firm,** and subject to:
(i) Site verification of the following design assumptions ...Existing structure is built as per drawings and good practice at the time.....
(ii) All proprietary products meeting their performance specification requirements;

**I believe on reasonable grounds** that a) the building, if constructed in accordance with the drawings, specifications, and other documents provided or listed in the attached schedule, will comply with the relevant provisions of the Building Code and that b), the persons who have undertaken the design have the necessary competency to do so. I also recommend the following level of construction monitoring/observation:
☒CM1 ☐CM2 ☐CM3 ☐CM4 ☐CM5 (Engineering Categories) or ☐ as per agreement with owner/developer (Architectural)

I, Mary Ann Halliday..... am:
(Name of Design Professional)

☒CPEng 67073.....#

☐Reg Arch ..... .#

I am a Member of : ☒ IPENZ ☐NZIA and hold the following qualifications:CPEng, ME (Civil).....
The Design Firm issuing this statement holds a current policy of Professional Indemnity Insurance no less than $200,000*.
The Design Firm is a member of ACENZ: ☒

SIGNED BY Mary Ann Halliday ..... ON BEHALF OF **Opus International Consultants** .....
(Design Firm)

Date31/10/2014..... (signature).....

*Note: This statement shall only be relied upon by the Building Consent Authority named above. Liability under this statement accrues to the Design Firm only. The total maximum amount of damages payable arising from this statement and all other statements provided to the Building Consent Authority in relation to this building work, whether in contract, tort or otherwise (including negligence), is limited to the sum of $200,000*.*

This form is to accompany **Form 2 of the Building (Forms) Regulations 2004** for the application of a Building Consent.

# CALCULATION SHEET

Project/Task/File No: BRICKS ROW

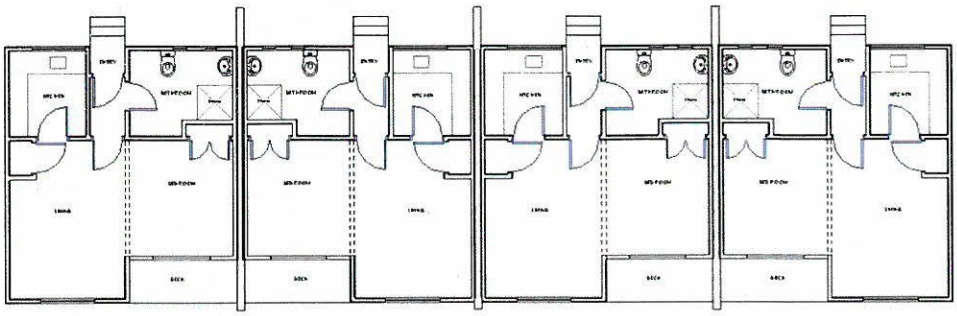
Project Description: SUBFLOOR STRENGTHENING

Sheet No 1 of

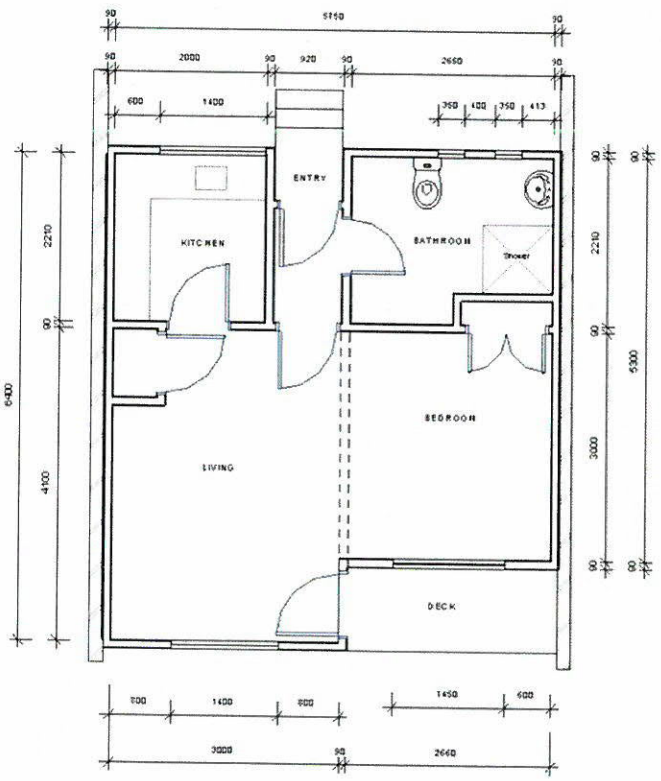
Office:

Computed: 29/5/14

Check: / /



PLAN




PLAN - 1 UNIT

OPUS

**CALCULATION SHEET**

Project/Task/File No: BRIGGS ROW

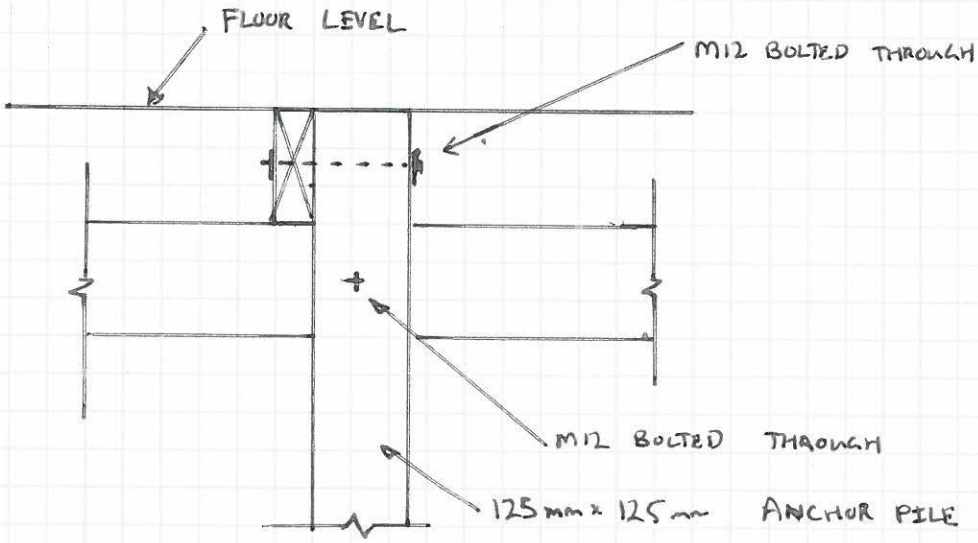
Project Description: ANCHOR PILE CONNECTION

Sheet No of

Office:

Computed: MP 4/ 6 /14

Check: / /

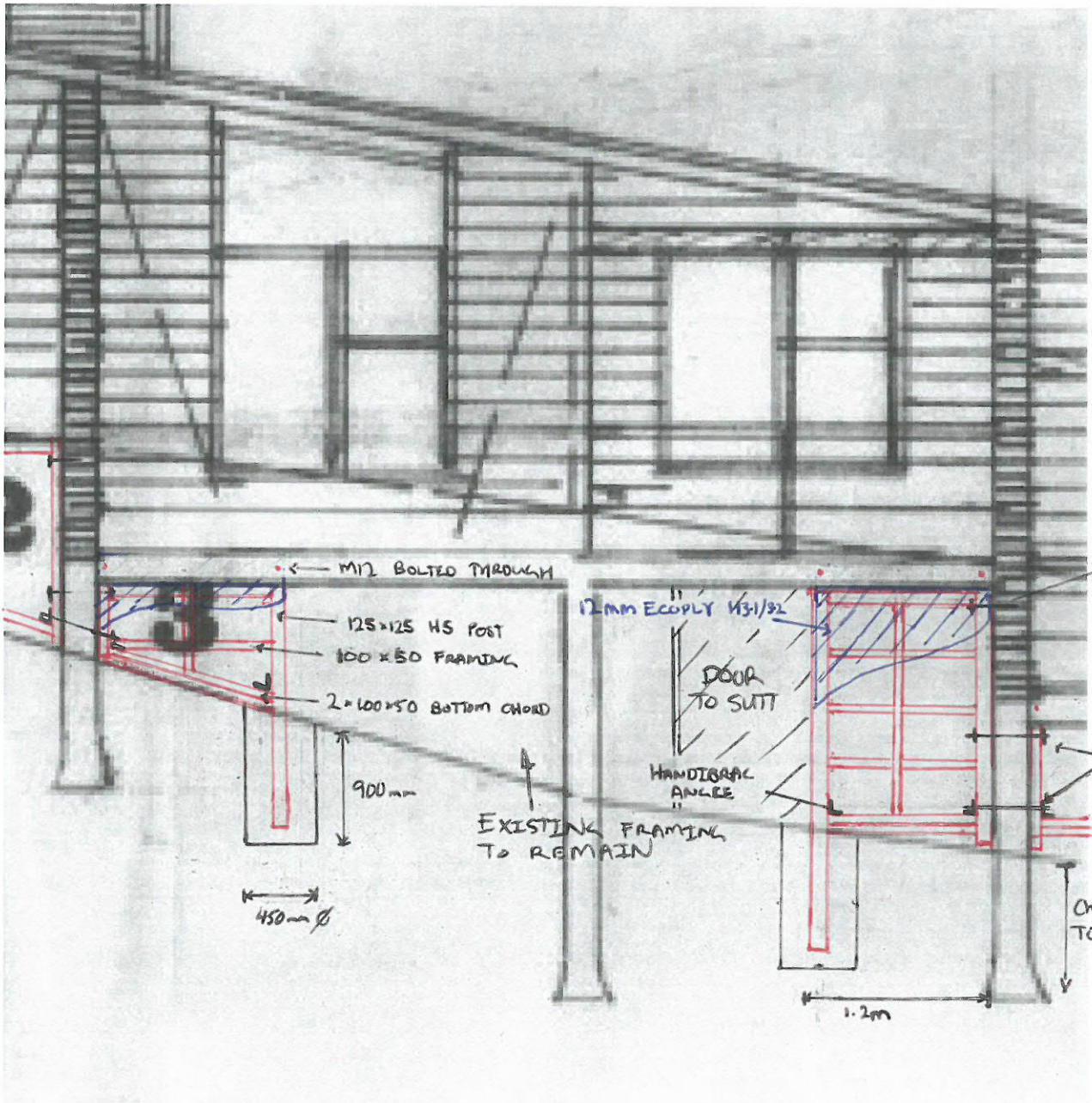



ANCHOR PILE BEARER / JOIST CONNECTION

– LOOKING EAST

OPUS

# BRIGGS ROW - TYPICAL SUBFLOOR STRENGTHENING




ECOPLY FASTENERS - 300mm CENTRES FOR INTERMEDIATE STUDS
150 mm CENTRES AROUND THE PERIMETER

- 50 x 2.8mm STAINLESS STEEL FLATHEAD NAILS

**CALCULATION SHEET**

Project/Task/File No: Briggs Row Remedial Detail

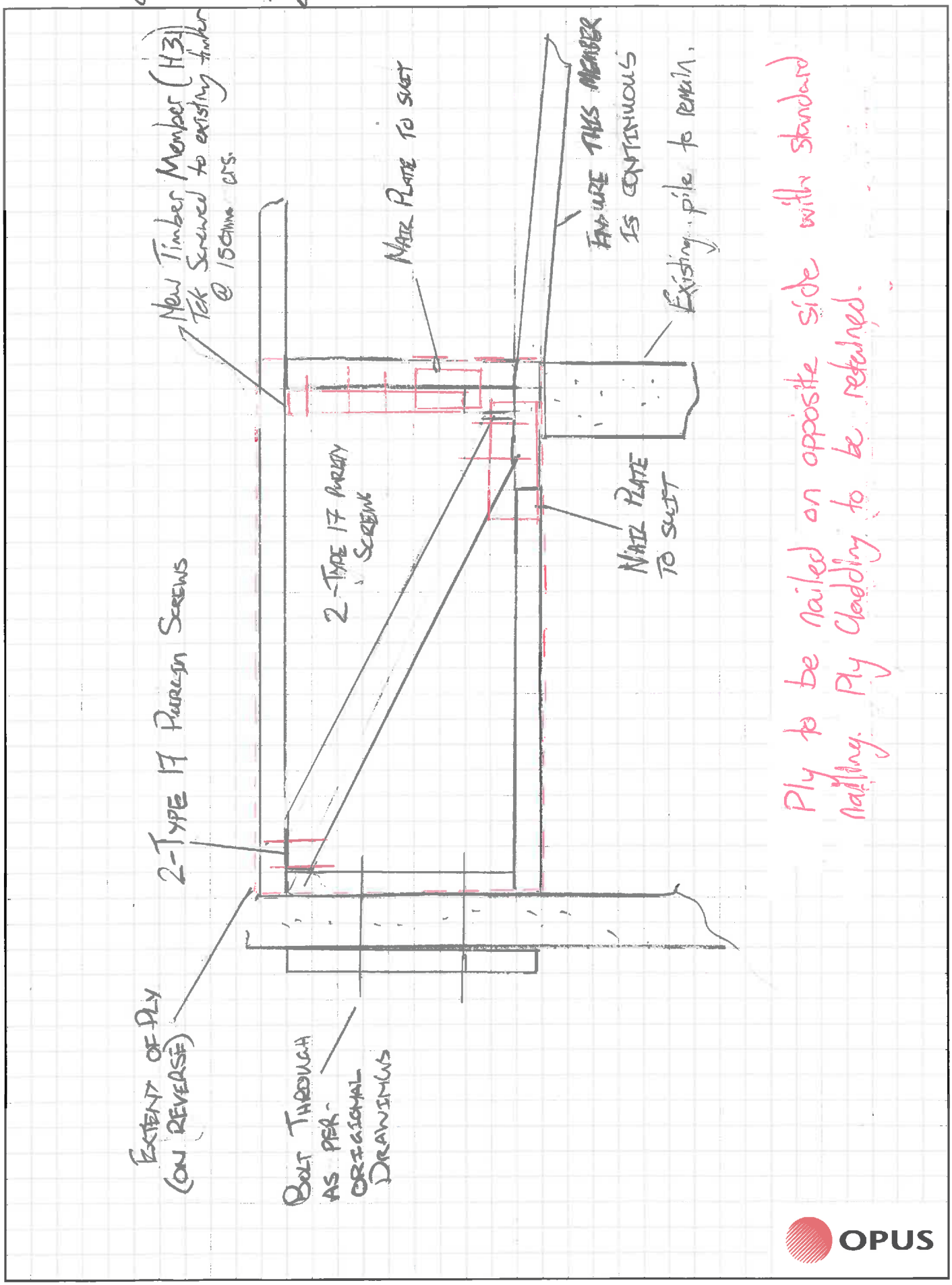
Project Description: For units where concrete paths impede nailing for plywood.

Sheet No 1 of 1

Office: CHK LMH

Computed: 5/6/15

Check: / /



**FORM OF PRODUCER STATEMENT PS3 – CONSTRUCTION**
At project completion, this form shall be completed by the building contractor and supplied to the Engineer.

**ISSUED BY: CORBEL CONSTRUCTION**……
(Building Contractor)

**TO: CHRISTCHURCH CITY COUNCIL**……
(Owner/Principal)

**IN RESPECT OF: SUB-FLOOR STRENGTHENING WORKS**……
(Description of Contract Works)

**AT: 31 WINCHESTER STREET, LYTTELTON** ……
(Address)

**T/A: CHRISTCHURCH CITY COUNCIL**…… **BUILDING CONSENT No: BCN/2014/12204**…
(Territorial Authority / Building Consent Authority)

The above Building Contractor has contracted to the above Owner/Principal to carry out and complete certain building works in accordance with the contract, titled

PRO3519 Briggs Row Strengthening and Repairs – Contract # 4600001353/026..... ("the contract")
(Title of building contract)

I James French..... a duly authorised representative of the
(Builder's Authorised Agent)

above building contractor, believe on reasonable grounds that the above building contractor has carried out and completed

□All √ Part only as specified in the attached particulars

of the building works in accordance with the contract.

……
(Signature of Authorised Agent on behalf of the Building Contractor)

26/11/2015……
(Date)

213 Lichfield Street.....

Christchurch……
(Address)

*This producer statement is confirmation by the builder(s) that they have carried out the building work in accordance with the drawings, specifications (and site amendments) that are part of the contract / building consent documents.*

*Work covered by this statement should have been supervised and checked by suitably qualified trades-persons.*

*The Engineer requires this producer statement and a copy of the T/A's building consent conditions, to confirm that items of the contract that he has not personally examined, have in fact been built according to the documents, so that the Engineer may issue appropriate documents to the T/A for it to release the Code Compliance Certificate.*

IPENZ ENGINEERS NEW ZEALAND | NEW ZEALAND INSTITUTE OF ARCHITECTS INCORPORATED | ACENZ

Building Code Clause(s) B1 & B2 .

# PRODUCER STATEMENT – PS4 – CONSTRUCTION REVIEW

(Guidance notes on the use of this form are printed on page 2)

**ISSUED BY**: Opus International Consultants Ltd .....
*(Construction Review Firm)*

**TO:** Christchurch City Council .....
*(Owner/Developer)*

**TO BE SUPPLIED TO:** Christchurch City Council .....
*(Building Consent Authority)*

**IN RESPECT OF:** Subfloor Bracing.....
*(Description of Building Work)*

**AT:** Briggs Row Housing Complex, 31 Winchester Street, Lyttleton .....
(Address)
..... **LOT**..... **DP** ..... **SO** .....

.....has been engaged by.....
*(Construction Review Firm)*

To provide☐CM1☒CM2☐CM3☐CM4☐CM5*(Engineering Categories)* or ☐ observation as per agreement with owner/developer

or ☐other .....services
*(Extent of Engagement)*

in respect of clause(s) B1 and B2 of the Building Code for the building work described in

documents relating to Building Consent No. BCN / 2014 / 122204.....
and those relating to

Building Consent Amendment(s) Nos. .....issued during the

course of the works. We have sighted these Building Consents and the conditions of attached to them.

Authorised instructions / variations(s) No. Remedial detail, dated 5/6/2015..... (copies attached)

or by the attached Schedule ☐ have been issued during the course of the works.

On by the basis of ☒this ☐these review(s) and information supplied by the contractor during the course of the works and **on behalf of the firm** undertaking this Construction Review, **I believe on reasonable grounds** that ☐All ☒Part only of the building works have been completed in accordance with the relevant requirements of the Building Consent and Building Consent Amendments identified above, with respect to Clause(s) B1 and B2 of the Building Code.
I also believe on reasonable grounds that the persons who have undertaken this construction review have the necessary competency to do so.

I, Mary Ann Halliday .....am:
*(Name of Construction Review Professional)*

☐CPEng No. 67073 .....

☐Reg Arch No. .....

I am a Member of : ☒IPENZ ☐NZIA and hold the following qualifications: ME(Civil), CPEng .....

The Construction Review Firm issuing this statement holds a current policy of Professional Indemnity Insurance no less than $200,000*.
The Construction Review Firm is a member of ACENZ : ☒

**SIGNED BY** Mary Ann Halliday ..... **ON BEHALF OF** Opus International Consultants Ltd .....

Date: 21 / 12 / 2015..... Signature:.....

*Note: This statement shall only be relied upon by the Building Consent Authority named above. Liability under this statement accrues to the Design Firm only. The total maximum amount of damages payable arising from this statement and all other statements provided to the Building Consent Authority in relation to this building work, whether in contract, tort or otherwise (including negligence), is limited to the sum of $200,000*.*

This form is to accompany **Forms 6 or 8 of the Building (Form) Regulations 2004** for the issue of a Code Compliance Certificate.

**Opus International Consultants Ltd**
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